

11-15-00

1A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Docket No. 93-C-077C1  
Prior Application No.: 08/169,337  
First Named Inventor: Loi N. Nguyen et al

Examiner: L. Pham  
Art Unit: 1107

ASSISTANT COMMISSIONER FOR PATENTS  
WASHINGTON, D.C. 20231

Sir: This is a request for filing a   X   **continuation**  
           **continuation-in-part**  
           **divisional**

application under **37 CFR 1.53(b)**, of pending prior application serial no. 08/169,337, filed on December 17, 1993, for METHOD AND INTERLEVEL DIELECTRIC STRUCTURE FOR IMPROVED METAL STEP COVERAGE.

1.   X   Enclosed is a complete copy of the prior application **including the oath or declaration as originally filed** and an affidavit or declaration verifying it as a true copy. (See No. 14 for declaration.)
2.            New formal drawings are enclosed.
3.            A preliminary amendment is enclosed. (Claims added by this amendment have been properly numbered consecutively beginning with the number next following the highest numbered original claim in the prior application.)
4.   X   Also enclosed: Return Postcard
5.            A verified statement to establish small entity status under 37 CFR 1.9 and 1.27    is enclosed            was filed in the prior application and such status is still proper and desired (37 CFR 1.28(a)).
6.            Cancel in this application original claims    of the prior application before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)
7.   X   Amend the specification by inserting the following sentence before the first line: "This is a   X   Continuation,    Continuation-in-Part or            Division of application serial no. 08/169,337, filed December 17, 1993, currently pending."
8.            Priority of application serial No.           , filed on           , in            is claimed under 35 U.S.C. 119. The certified copy has been filed in prior application serial no.           , filed           .

Express Mail No. EL139163824US

I hereby certify that this paper or fee is being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 on the date indicated below and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231, on November 14, 2000.

By

Beth Costner  
Beth Costner

9. ☒ The filing fee is calculated below:

CLAIMS AS FILED IN THE PRIOR APPLICATION  
LESS ANY CLAIMS CANCELLED BY AMENDMENT NOW

Basic Fee		<b>\$710.00</b>
Extra Total Claims (___ x \$18.00)	=	0.00
Extra Independent Claims (___ x \$80.00)	=	0.00
Total Filing Fee:	=	<b>\$710.00</b>

10. \_\_\_\_\_ The Commissioner is hereby authorized to charge \$ and any additional fee which may be required, or credit any overpayment to Deposit Account . *A duplicate of this sheet is enclosed.*

11. \_\_\_\_\_ A check in the amount of \$0.00 is enclosed.

12. ☒ The prior application is assigned of record to STMicroelectronics, Inc..

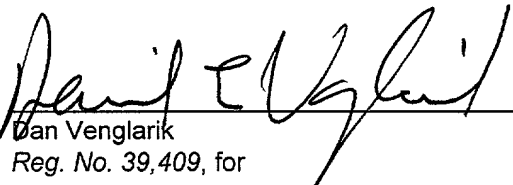
13. ☒ The power of attorney in the prior application is to Lisa K. Jorgenson, Reg. No. 34,845.

- a. ☒ The power of attorney appears in the original papers in the prior application.
- b. \_\_\_\_\_ A new power of attorney is enclosed (*adding prosecution attorneys*).
- c. \_\_\_\_\_ Since the power of attorney does not appear in the original papers, a copy of the power in the prior application is enclosed.
- d. ☒ Address all future communication to: **Lisa K. Jorgenson, Esq.,  
STMicroelectronics, Inc., 1310 Electronics Drive, Carrollton, Texas 75006-5039.**

14. ☒ I hereby verify that the attached papers are a true copy of prior application serial no. 08/169,337, as originally filed on December 17, 1993.

The undersigned declares further that all statements made herein of his or her own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application of any patent issuing thereon.

November 14, 2000  
Date

  
Dan Venglarik  
Reg. No. 39,409, for

Address of signatory:  
FELSMAN, BRADLEY, VADEN,  
GUNTER & DILLON, LLP  
201 Main Street, Suite 1600  
Fort Worth, Texas 76102  
817/332-8143

\_\_\_\_ Inventor(s)  
\_\_\_\_ Assignee of complete interest  
\_\_\_\_ Attorney or agent of record  
☒ Filed under §1.34(a)

---

# Method and Interlevel Dielectric Structure for Improved Metal Step Coverage

---

U.S. Patent Application of:

Loi N. Nguyen,  
Ravishankar Sundaresan,

Inventor

Inventor

SGS-Thomson Microelectronics, Inc.,

Assignee

Attorney's Docket No. 93-C-77/SGS-049  
Robert Groover, REG.PAT.ATTY.

DOCKET # 93-C-77/SGS-049

## Background and Summary of the Invention

The present invention relates to integrated circuit structures and fabrication methods.

5 In integrated circuit fabrication, a key area of concentration has been the fabrication of contacts. Contact holes must usually be etched down through a significant thickness of interlevel dielectric, and significant issues arise. Contact holes are normally etched simultaneously to the active region and to the poly-1 level (polycide gate conductor), and thus the interlevel dielectric will be much thicker over  
10 some locations, especially when the dielectric has been planarized. (Planarization of the interlevel dielectric is highly desirable to minimize topographic excursion, but means that in some locations the contact holes may tend to have a very large aspect ratio.) This means that a large amount of overetch must be tolerated at the contacts to the poly-1  
15 level.

For best mechanical properties of the metal layer, it would be desirable to provide sloped contact hole sidewalls. This has commonly been done with oxide reflow techniques, in which a short high-temperature treatment of a doped silicate glass produces nicely rounded  
20 corners (due to the surface tension effects on the silicate glass layer when it softens). One problem with this approach is that the required time at high-temperature is increasingly undesirable as geometries shrink.

Another approach has been to use a fairly isotropic etch, to  
25 produce a contact hole with sloped sidewalls; but this consumes a large area. The lateral spread of the contact sidewalls means that a significant spacing must be required between contacts to active and the

poly-1 layer, to prevent shorts to poly-1.

To achieve the best packing density, it would be desirable to use holes with nearly vertical sidewalls. However, such holes have a high aspect ratio (height/width ratio), and pose processing difficulties. Such geometries may present difficulties in completely filling the contact hole, or may cause an undesirable lack of planarity where the metal layer crosses over the hole. Such problems have been addressed by "stud contact" processes (where deposition and etchback of a highly conformal metal, such as W, precede deposition of a following metal such as Al:Cu). However, such processes add expense and complexity, and are more often used for vias than contacts.

One proposed method uses a second poly as the "landing pads" for bitline contacts in the matrix. In this way, the wordlines are protected thereby allowing for zero contact-to-gate spacing. The drawback is that this method cannot be used in the periphery due to contact resistance problems which result in slower operation of the device.

Another method uses a silicon nitride deposition on top of the polycide prior to pattern and etch. (See Singer, "A New Technology for Oxide Contact and Via Etch", SEMICONDUCTOR INTERNATIONAL, August 1993, p.36, which is hereby incorporated by reference.) Through the use of highly selective nitride to oxide etch selectivities, this will reduce the possibility of the contact touching the top of the polycide; however, it can still make contact along the sidewall due to the removal of the oxide spacer. Additionally, this does not address the problem of overetching the field oxide during the spacer etch.

Still another proposed method uses an  $\text{Al}_2\text{O}_3$  etch-stop layer to

achieve a zero-margin contact process. (See Fukase *et al.*, "A Margin-Free Contact Process Using an  $\text{Al}_2\text{O}_3$  Etch-Stop Layer for High-Density Devices," 1992 IEDM PROCEEDINGS 33.3, which is hereby incorporated by reference.)

5       The present application sets forth a new approach to contact formation, using a combination of isotropic and anisotropic etch steps to produce a contact profile which has steep sidewalls at its bottom portion and sloped sidewalls at its top portion. This approach recognizes that the constraints on the top part of the contact hole are  
10 different from those on the bottom part of the contact hole, and accordingly obtains the advantages of both steep-sidewall and sloped-sidewall geometries:

at the lower level, the contact occupies only a small area, and hence it  
is not necessary to impose large minimum spacing from  
15 the contact to adjacent polysilicon;  
at the upper level, the contact has nicely sloped sidewalls, so that  
problems of metal voids and cracking, and  
electromigration are greatly simplified.

The present application also describes a new method of forming  
20 sub-micron contact utilizing  $\text{Si}_3\text{N}_4$  (or other dielectric film with good etch selectivity to oxide film) as an etch stop for a WET oxide etch. After the wet etch, an anisotropic plasma etch is used to cut a substantially vertical contact hole through the nitride and underlying layers. Thus, the resulting contact hole has a "Y"-shaped profile.

25       Since the lower silicate glass layer and the nitride layer are not highly planarized, they provide area-efficient protection of the devices from any lateral encroachments which might occur during contact

etching. Most of the planarization is performed in the upper silicate glass layer.

Thus, the lower silicate glass layer and the nitride layer provide self-aligned protection for the gate layer. This protection ensures that  
5 no possible combination of geometries will permit the contact etch to create a short circuit to the gate layer.

According to a disclosed class of innovative embodiments, there is provided: A fabrication method, comprising the steps of: providing a partially fabricated integrated circuit structure which includes  
10 **transistors**; forming an **interlevel dielectric** structure over said transistors, said interlevel dielectric including at least a **lower layer** having a first composition, a **middle layer** having a second composition which is different from said first composition, and an **upper layer** having a third composition which is different from said  
15 second composition; etching through said upper layer, using a relatively isotropic etch process which is selective to said second composition; etching through said middle and lower layers, using a relatively anisotropic etch process, to expose portions of said transistors; and depositing and patterning a thin-film conductor layer,  
20 to interconnect said transistors in a desired pattern.

According to another disclosed class of innovative embodiments, there is provided: A fabrication method, comprising the steps of: providing a partially fabricated integrated circuit structure which includes **transistors**; forming an **interlevel dielectric** structure over  
25 said transistors, said interlevel dielectric including at least a **lower layer** consisting predominantly of silicate glass, a **middle layer** consisting predominantly of silicon nitride, and an **upper layer**

consisting predominantly of doped silicate glass; etching through said upper layer, using a relatively isotropic etch process which is selective to said second composition; etching through said middle and lower layers, using a relatively anisotropic etch process, to expose portions of said transistors; and depositing and patterning a thin-film conductor layer, to interconnect said transistors in a desired pattern.

According to another disclosed class of innovative embodiments, there is provided: A method, comprising the steps of: providing a partially fabricated integrated circuit structure which includes transistors; forming an interlevel dielectric structure over said transistors, said interlevel dielectric including at least a lower layer having a first composition, a middle layer having a second composition which is different from said first composition, and an upper layer having a third composition which is different from said second composition; etching through said upper layer, using a wet etch process which is selective to said second composition; etching through said middle and lower layers, using a relatively anisotropic plasma etch process, to expose portions of said transistors; and depositing and patterning a thin-film conductor layer, to interconnect said transistors in a desired pattern.

According to another disclosed class of innovative embodiments, there is provided: A method, comprising the steps of: providing a partially fabricated integrated circuit structure which includes transistors; forming an interlevel dielectric structure over said transistors, said interlevel dielectric including at least a lower layer having a first composition, a middle layer having a second composition which is different from said first composition, and an



**upper layer** having a third composition which is different from said second composition; etching through said upper layer, using a wet etch process which is selective to said second composition; etching through said middle and lower layers, using a relatively anisotropic plasma etch process, to expose portions of said transistors; and depositing and patterning a thin-film metal layer, without any intermediate etchback steps, to interconnect said transistors in a desired pattern.

According to another disclosed class of innovative embodiments, there is provided: An integrated circuit, comprising: a **substrate** having **transistors** formed at one surface thereof; an **interlevel dielectric** overlying said transistors, and having at least upper, middle, and lower layers, said middle layer having a different composition from said upper layer and from said lower layer, and having contact holes therein extending vertically therethrough, said contact holes having vertical sidewalls in said lower layer and sloped sidewalls in said upper layer; and a patterned thin-film **metal layer** extending through said contact holes to interconnect said transistors in a desired electrical configuration.

### Brief Description of the Drawing

The present invention will be described with reference to the accompanying drawings, which show important sample embodiments of the invention and which are incorporated in the specification hereof by reference, wherein:

Figure 1 shows a partially fabricated integrated circuit structure, complete through formation of transistor structures;

Figure 2 shows the integrated circuit structure of Figure 1, at a later stage of fabrication according to the present invention;

Figure 3 shows the integrated circuit structure of Figure 2, after masking has been formed and an isotropic etch has been performed at contact hole locations;

Figure 4 shows the integrated circuit structure of Figure 3, after an anisotropic etch has been performed using the contact mask and metal has been deposited and patterned.

Figure 5 is a micrograph which shows an example of a contact fabricated using the disclosed inventions.

## Description of the Preferred Embodiments

The numerous innovative teachings of the present application will be described with particular reference to the presently preferred embodiment. However, it should be understood that this class of  
5   embodiments provides only a few examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily delimit any of the various claimed inventions. Moreover, some statements may apply to some inventive features but not to others.

10       Figure 1 shows a partially fabricated integrated circuit structure, complete through formation of transistor structures. Fabrication to this point has been entirely conventional, *e.g.* with preparation of silicon wafer **200**, formation of N-wells and P-wells, formation of field oxide  
15   **202** to *e.g.* 6000Å, sacrificial oxide grown and stripped, growth of gate oxide **204** to *e.g.* 150Å, threshold voltage adjustment, deposition of polycide gate **210** to *e.g.* 3500Å total thickness, LDD and/or HALO implant or implants, formation of sidewall spacers **220**, and N+ and P+ source/drain implants. This results in the structure of Figure 1.

Thereafter a somewhat unusual interlevel dielectric is deposited.  
20   In the presently preferred embodiment, this is performed by the steps of:

1. deposit undoped oxide **230** to *e.g.* 1000 to 2000 Å.
2. deposit a first layer **232** of BPSG (borophosphosilicate glass) or PSG (phosphosilicate glass) to *e.g.* 1000 to 2000 Å.
- 25   3. deposit Si<sub>3</sub>N<sub>4</sub> layer **234** to *e.g.* 500 to 1000 Å
4. deposit a second layer **236** of BPSG to *e.g.* 3000 to 4000 Å;
5. BPSG reflow/densification (*e.g.* 25 minutes at a temperature of

875°C, in the presently preferred embodiment).

This produces the structure of **Figure 2**. In this structure, note that the reflow of the second BPSG layer has produced some planarization.

5 A photoresist layer **240** is now deposited, baked, patterned, and developed, to provide apertures over desired contact hole locations. A wet etch is now performed (*e.g.* 250 minutes at a temperature of 25°C in an aqueous solution of 7:1 buffered HF). This etch chemistry has essentially infinite selectivity to nitride, so the nitride layer 234 provides a good etch stop.

10 This produces the structure shown in **Figure 3**. Note that the wet etch has significantly undercut the photoresist mask 240.

An anisotropic etch is now performed, using *e.g.* a conventional fluoro-etch chemistry which is not selective between oxide and nitride. This cuts through nitride 234, and underlying silicate glass layers  
15 230/232, to expose silicon at the desired contact locations.

Metal **250** is now deposited, *e.g.* 600Å of Ti followed by 1000Å of TiN followed by rapid thermal annealing (to induce silicidation in the contact hole) followed by deposition of a metal such as Al:Cu. The metal layer is then patterned to achieve the desired circuit  
20 configuration.

This results in the structure of **Figure 4**.

Processing may then continue with conventional further steps, *e.g.* deposition of a further interlevel dielectric and a second metal layer (if desired), contact sinter (if needed), deposition and  
25 densification of a protective overcoat and removal thereof to expose contact pad locations.

Figure 5 is a micrograph which shows an example of a contact

fabricated using the disclosed inventions.

### Advantages

The disclosed innovations provide at least the following advantages:

- 5     • metal-to-gate shorts due to overetch during wet oxide etch are completely prevented;
- 10    • The full film thickness of the first BPSG film is available for gettering, which improves device reliability. (Silicate glasses, unlike nitride, have the ability to trap ionic impurities.)
- 15    • Significant contact aspect ratio reduction to improve metal step coverage, without degrading the contact-to-poly spacing. the reduced aspect ratio provides better sidewall coverage for the adhesion and diffusion-barrier layers which are the first part of the metallization stack, and helps to protect against voids and step coverage difficulties.
- 20    • The  $\text{Si}_3\text{N}_4$  film also provides passivation against hydrogen. Exposure to hydrogen can increase the value of a polysilicon resistor by a factor of 2x or 3x. Thus, in device structures using "poly R" resistor structures, indiffusion of hydrogen may cause a shift in resistor values. The nitride layer thus helps to prevent this, and provides improved stability.
- 25    • A simple metallization process, without a plug metal deposition and intermediate etchback, can be used.
- There is no need to reflow the interlevel dielectric after contact etch.

### **Further Modifications and Variations**

It will be recognized by those skilled in the art that the innovative concepts disclosed in the present application can be applied in a wide variety of contexts. Moreover, the preferred implementation can be modified in a tremendous variety of ways. Accordingly, it should be understood that the modifications and variations suggested below and above are merely illustrative. These examples may help to show some of the scope of the inventive concepts, but these examples do not nearly exhaust the full scope of variations in the disclosed novel concepts.

Of course a variety of structures can be used to implement the polysilicon or polycide gate. Similarly, a wide variety of materials, and of combinations of materials, can be used to implement the metal layer.

Of course, the specific etch chemistries, layer compositions, and layer thicknesses given are merely illustrative, and do not by any means delimit the scope of the claimed inventions.

The invention can also be adapted to other combinations of dielectric materials in the interlevel dielectric. For example, phosphosilicate glass or germanosilicate glass can be used instead of the BPSG of the presently preferred embodiment.

The innovative process preferably uses at least a three-level dielectric stack, in which the top layer can be etched selectively with respect to the middle layer. Preferably the top and bottom layers are both silicate glasses, but it will be recognized by those skilled in the art that other materials can be substituted for the silicates or for the nitride. It will also be recognized that additional layers can be added

if desired.

It should be recognized that the first etch step does not have to be perfectly isotropic, but may still function adequately with a modest anisotropy. It should also be noted that the first etch step can be implemented with a high-pressure plasma or afterglow etch instead of a wet etch, IF the etch chemistry used provides high selectivity to nitride.

Similarly, while the sidewall spacers 220 are normally used, they are not strictly necessary to the practice of the invention.

While the disclosed process could be used for via formation, it is much less preferable in that context. The dielectric constant for nitride is about twice that for oxide, so that the parasitic capacitive loading on the metal lines would be increased.

While the inventions have been described with primary reference to a single-poly process, it will be readily recognized that these inventions are equally applicable to double-poly or triple-poly structures and processes. Similarly, while the contact from first metal to first poly and active has been particularly described, it will be readily recognized that the disclosed inventions are equally applicable to processes with multiple layers of metal.

The innovative process teachings may also be adapted for contact formation in bipolar or other device technologies.

Similarly, it will be readily recognized that the described process steps can also be embedded into hybrid process flows, such as BiCMOS or smart-power processes.

As will be recognized by those skilled in the art, the innovative concepts described in the present application can be modified and

varied over a tremendous range of applications, and accordingly the scope of patented subject matter is not limited by any of the specific exemplary teachings given.



## CLAIMS

What is claimed is:

1. A fabrication method, comprising the steps of:

(a.) providing a partially fabricated integrated circuit structure which includes **transistors**;

5 (b.) forming an **interlevel dielectric** structure over said transistors, said interlevel dielectric including at least

(i.) a **lower layer** having a first composition,

(ii.) a **middle layer** having a second composition which is different from said first composition, and

10 (iii.) an **upper layer** having a third composition which is different from said second composition;

(c.) etching through said upper layer, using a relatively isotropic etch process which is selective to said second composition;

15 (d.) etching through said middle and lower layers, using a relatively anisotropic etch process, to expose portions of said transistors; and

(e.) depositing and patterning a thin-film conductor layer, to interconnect said transistors in a desired pattern.

2. The method of Claim 1, wherein said transistors comprise insulated-gate field-effect transistors.

3. The method of Claim 1, wherein said middle layer consists of silicon nitride, and said etching step (c.) comprises wet etching in hydrofluoric acid.
4. The method of Claim 1, wherein said lower layer comprises a doped silicate glass over an undoped silica layer.
5. The method of Claim 1, wherein said upper layer consists of borophosphosilicate glass.
6. The method of Claim 1, wherein said etching step (c.) comprises wet etching.
7. The method of Claim 1, wherein said etching step (d.) comprises plasma etching.
8. The method of Claim 1, wherein said metal layer comprises an adhesion layer, a conductive diffusion barrier layer atop said adhesion layer, and a conductor layer over said diffusion barrier layer.

9. A fabrication method, comprising the steps of:

(a.) providing a partially fabricated integrated circuit structure which includes **transistors**;

(b.) forming an **interlevel dielectric** structure over said transistors, said interlevel dielectric including at least

(i.) a **lower layer** consisting predominantly of silicate glass,

(ii.) a **middle layer** consisting predominantly of silicon nitride, and

(iii.) an **upper layer** consisting predominantly of doped silicate glass;

(c.) etching through said upper layer, using a relatively isotropic etch process which is selective to said second composition;

(d.) etching through said middle and lower layers, using a relatively anisotropic etch process, to expose portions of said transistors; and

(e.) depositing and patterning a thin-film conductor layer, to interconnect said transistors in a desired pattern.

10. The method of Claim 9, wherein said transistors comprise insulated-gate field-effect transistors.

11. The method of Claim 9, wherein said middle layer consists of silicon nitride, and said etching step (c.) comprises wet etching in hydrofluoric acid.

12. The method of Claim 9, wherein said lower layer comprises a doped silicate glass over an undoped silica layer.

13. The method of Claim 9, wherein said upper layer consists of borophosphosilicate glass.
14. The method of Claim 9, wherein said etching step (c.) comprises wet etching.
15. The method of Claim 9, wherein said etching step (d.) comprises plasma etching.
16. The method of Claim 9, wherein said metal layer comprises an adhesion layer, a conductive diffusion barrier layer atop said adhesion layer, and a conductor layer over said diffusion barrier layer.

17. A method, comprising the steps of:

(a.) providing a partially fabricated integrated circuit structure which includes **transistors**;

(b.) forming an **interlevel dielectric** structure over said transistors, said interlevel dielectric including at least

(i.) a **lower layer** having a first composition,

(ii.) a **middle layer** having a second composition which is different from said first composition, and

(iii.) an **upper layer** having a third composition which is different from said second composition;

(c.) etching through said upper layer, using a wet etch process which is selective to said second composition;

(d.) etching through said middle and lower layers, using a relatively anisotropic plasma etch process, to expose portions of said transistors; and

(e.) depositing and patterning a thin-film conductor layer, to interconnect said transistors in a desired pattern.

18. The method of Claim 17, wherein said transistors comprise insulated-gate field-effect transistors.

19. The method of Claim 17, wherein said middle layer consists of silicon nitride, and said etching step (c.) comprises wet etching in hydrofluoric acid.

20. The method of Claim 17, wherein said lower layer comprises a doped silicate glass over an undoped silica layer.

21. The method of Claim 17, wherein said upper layer consists of borophosphosilicate glass.
22. The method of Claim 17, wherein said metal layer comprises an adhesion layer, a conductive diffusion barrier layer atop said adhesion layer, and a conductor layer over said diffusion barrier layer.
23. A method, comprising the steps of:
- (a.) providing a partially fabricated integrated circuit structure which includes **transistors**;
  - (b.) forming an **interlevel dielectric** structure over said transistors, said interlevel dielectric including at least
    - (i.) a **lower layer** having a first composition,
    - (ii.) a **middle layer** having a second composition which is different from said first composition, and
    - (iii.) an **upper layer** having a third composition which is different from said second composition;
  - (c.) etching through said upper layer, using a wet etch process which is selective to said second composition;
  - (d.) etching through said middle and lower layers, using a relatively anisotropic plasma etch process, to expose portions of said transistors; and
  - (e.) depositing and patterning a thin-film metal layer, without any intermediate etchback steps, to interconnect said transistors in a desired pattern.

24. The method of Claim 23, wherein said transistors comprise insulated-gate field-effect transistors.
25. The method of Claim 23, wherein said middle layer consists of silicon nitride, and said etching step (c.) comprises wet etching in hydrofluoric acid.
26. The method of Claim 23, wherein said lower layer comprises a doped silicate glass over an undoped silica layer.
27. The method of Claim 23, wherein said upper layer consists of borophosphosilicate glass.
28. The method of Claim 23, wherein said etching step (c.) comprises wet etching.
29. The method of Claim 23, wherein said etching step (d.) comprises plasma etching.
30. The method of Claim 23, wherein said metal layer comprises an adhesion layer, a conductive diffusion barrier layer atop said adhesion layer, and a conductor layer over said diffusion barrier layer.

31. An integrated circuit, comprising:

a **substrate** having **transistors** formed at one surface thereof;  
an **interlevel dielectric**

overlying said transistors, and

5 having at least upper, middle, and lower layers, said middle  
layer having a different composition from said upper layer  
and from said lower layer, and

having contact holes therein extending vertically therethrough,  
said contact holes having vertical sidewalls in said lower

10 layer and sloped sidewalls in said upper layer; and

a patterned thin-film **metal layer** extending through said contact  
holes to interconnect said transistors in a desired electrical  
configuration.

32. The integrated circuit of Claim 31, wherein said first and third  
materials both comprise silicate glasses.

33. The integrated circuit of Claim 31, wherein said transistors  
comprise insulated-gate field-effect transistors.

34. The integrated circuit of Claim 31, wherein said metal layer  
comprises an adhesion layer, a conductive diffusion barrier layer  
atop said adhesion layer, and a conductor layer over said  
diffusion barrier layer.

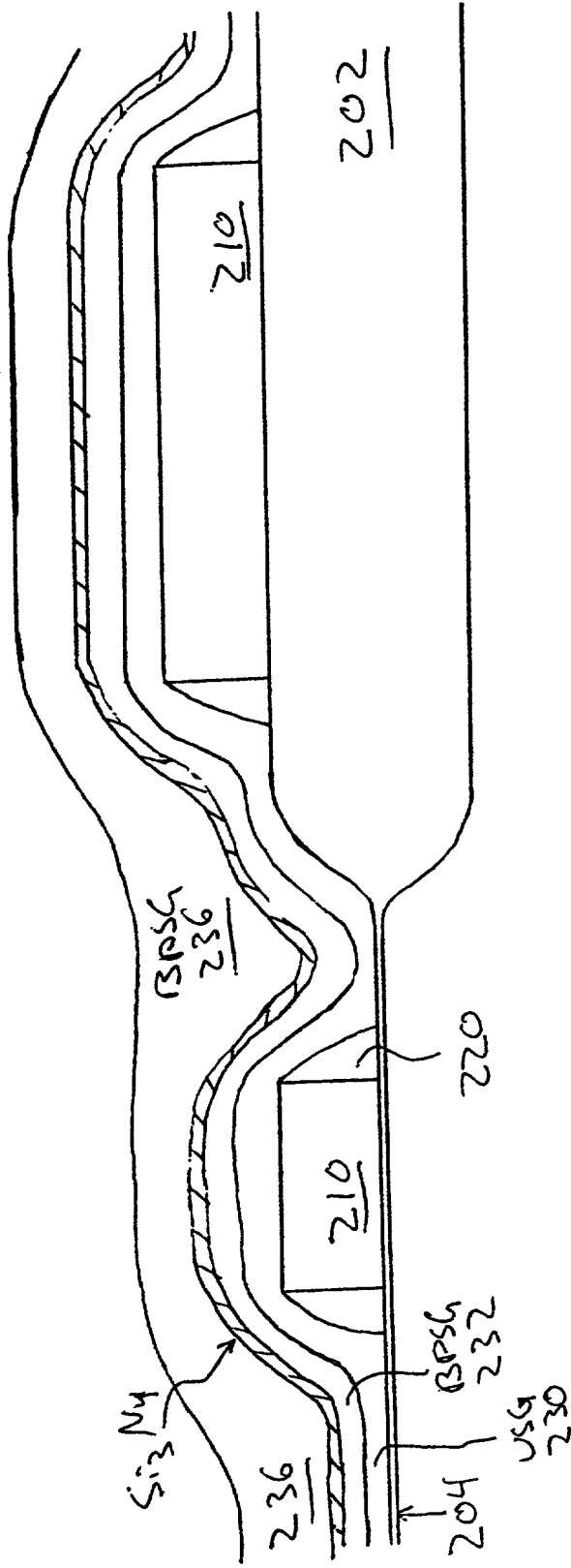


## ABSTRACT

5 A VLSI contact formation process in which a nitride layer is used to stop a wet oxide etch. An anisotropic plasma etch is used to cut a substantially vertical contact hole through the nitride and underlying layers. Thus, the resulting contact hole has a "Y"-shaped profile.

93-C-77





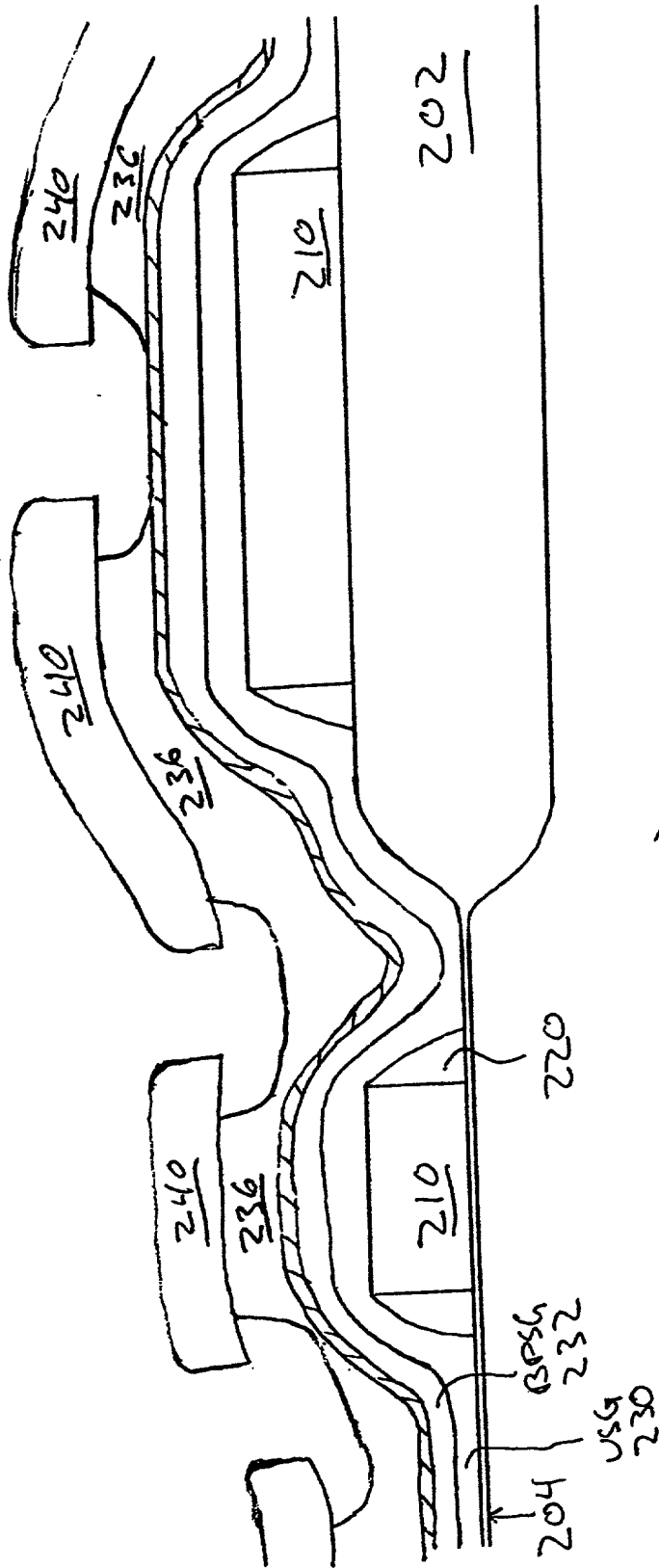


FIG. 3

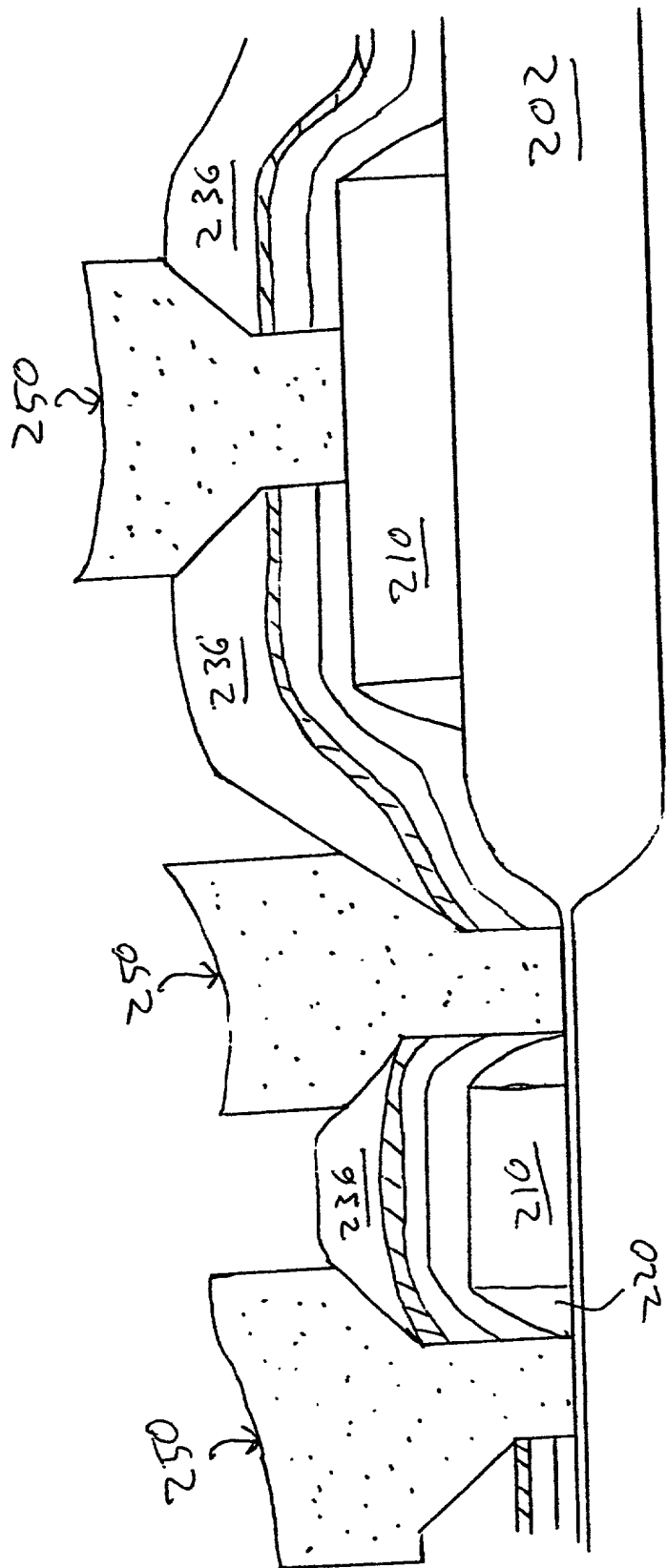


Fig. 4

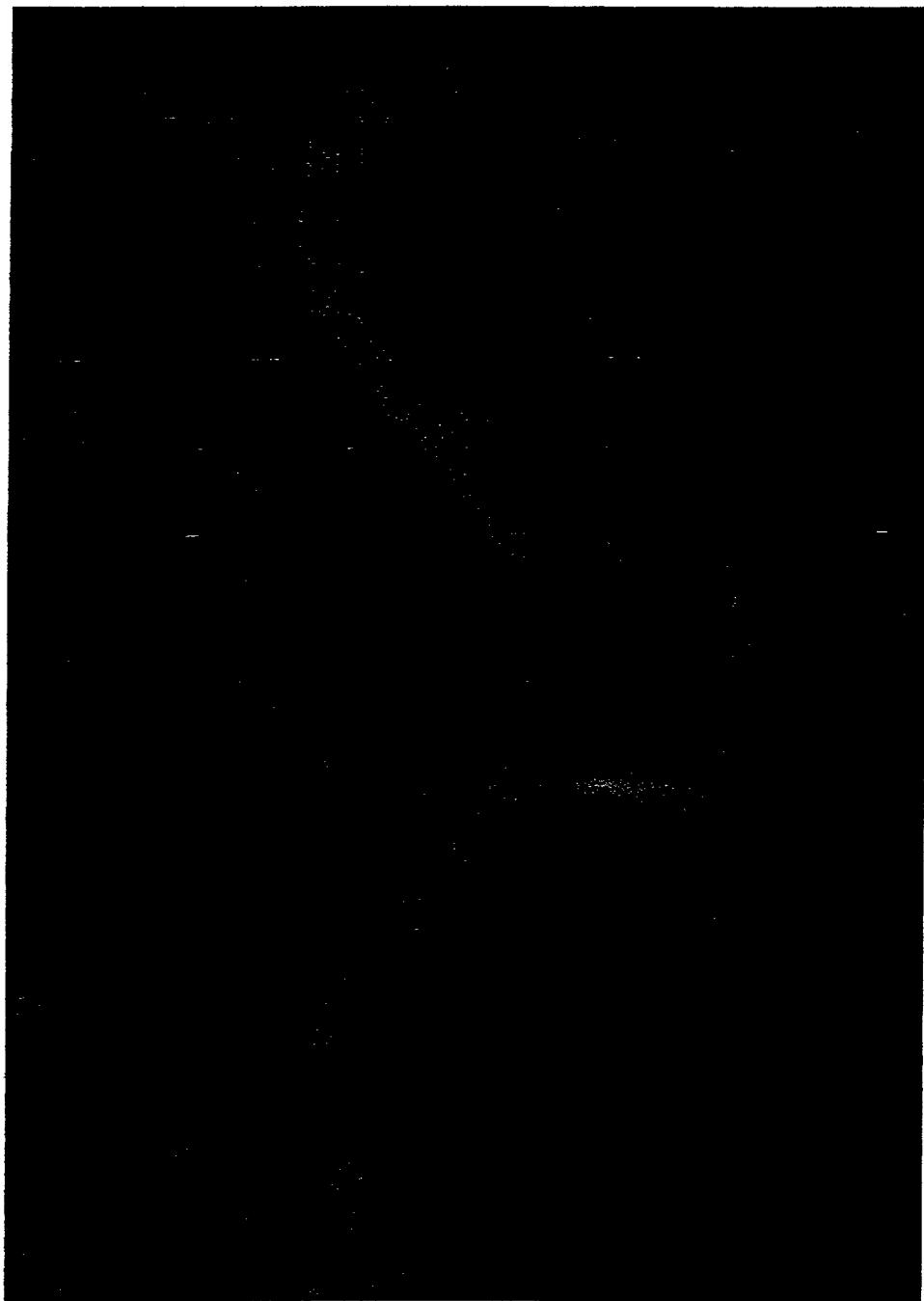


Fig. 5

**DECLARATION AND POWER OF ATTORNEY**

As a below-named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below.

I believe that I am an original, first and joint inventor of the innovative subject matter described and claimed in the U.S. patent application, entitled **Method and Interlevel Dielectric Structure for Improved Metal Step Coverage** (Att'y Docket No. SGS-049), which is attached hereto. .

I hereby state that I have reviewed and understand the contents of the above-identified U.S. patent application, **INCLUDING THE CLAIMS**.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulation, §1.56(a).

I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention or discovery thereof.

I do not know and do not believe that the claimed invention was ever patented or described in any printed publication in any country before my invention or discovery thereof.

I do not know and do not believe that the claimed invention was ever patented or made the subject of an inventor's certificate issued prior to the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns.

I do not know and do not believe that the claimed invention was ever patented or described in any printed publication in any country more than one year prior to the filing date of this U.S. application.

I do not know and do not believe that the claimed invention was ever in public use or on sale in the United States of America more than one year prior to the filing date of this U.S. application.

I hereby appoint Robert Groover, Reg.No.30,059, Richard A. Bachand, Reg.No.25,107, Lisa Jorgenson, Reg.No.34,845, and Betty Formby, Reg.No.36,536, to prosecute this application and transact all business in the Patent and Trademark Office connected therewith, and also to file and prosecute any corresponding application in any foreign country.

I hereby direct that all correspondence and telephone calls be addressed to:

Lisa Jorgenson  
LEGAL Dept.  
SGS-Thomson Microelectronics Inc.  
1310 Electronics Drive,  
Carrollton TX 75006

(214) 466-7414.

I hereby claim the benefit of foreign priority, under 35 U.S.C. §119, of any foreign application(s) for patent or inventor's certificate listed below:  
, filed (MM/DD/YY).

I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and may also jeopardize the validity of the application or any patent issued thereon.

Inventor: Loi Nguyen

Date: 12/17/93

Signature: Loi Nguyen

Residence and Mailing Address: 1724 Brighton Drive, Carrollton, Denton, Texas  
75007                      Citizenship: U.S.

Inventor: Ravishankar Sundaresan

Date: 12/17/93

Signature: Ravishankar Sundaresan

Residence and Mailing Address: 130 E. Ridgeway Drive, Garland, Texas 75040  
Citizenship: India